The second stage female lac cell under polarized light

(Hem. Homoptera)

BY

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Pabna.

(Láms. IV-VI).

The architecture of the lac cell shows its walls to be impregnated with a skeleton of hard wax fibres. Previously solvents, like alcohol and caustic soda solution, were used to dissolve away the lac resin leaving the waxes intact. It was however difficult to find the waxes in their original position undisturbed. A better method consists in subjecting the object to polarized light which selectively reveals the waxes as conspicuous constituents, whereas lac, being transparent, remains dark. The first stage lac cell has been successfully studied in this manner by one of us (Miss Noorun-Nisa Quadri). Here it is proposed to report similar findings extended to the second stage female larva and its cell. For comparison the male of a similar stage has been partly studied as well.

The male larva grows like a typical insect, flat and long. On the contrary the female, which also begins life as a fish-shaped larva, when it is a full grown adult, acquires a pear-shaped body, with its long axis vertical to the surface of the twig. This radical change in the direction of growth, from being horizontal to an object finally appearing perpendicular, characterizes the female, and this fact has to be remembered in appreciating the earlier indications collectively pointing to sex dimorphism. Moreover there are also subtle morphological differences between the early first stage larvae of the two sexes, as already illustrated (Noorun-Nisa Quadri, 1965. *Zool. Anz., Leipzig,* t. CLXXV, págs. 395-406).

The crawling larva has a delicate transparent skin. As soon as it has fixed itself to the host plant, the only part of the body exposed to

the atmosphere is its dorsal surface. It therefore starts first by protecting itself, for which it secretes a thin shield of hard wax. This wax-shield is divisible into eleven partitions or plates, each being produced by the body segment underneath. The shield as a whole is then identical in shape and size with the crawling larva and as such has been mistaken for its moult skin. The mistake was due in not knowing that the shield was constituted of wax. In fact the earlier entomologists, who studied the lac insect, hardly recognized the waxes produced by this insect, even though lac refiners fully knew wax to be a regular by-product of their industry. However it is possible to separate the wax shield free from the larval body and by its means identify the sex of the insect as has been done by one of us (S. Mahdihassan, 1963, *Eos, Madrid,* t. XXXIX, pág. 398, figs. 5 and 6).

Though the fact has not been explicitly mentioned before the first stage larva, as soon as it has formed its dorsal shield, when a little more than half grown, begins to secrete wax fibres in the form of ribbons from all over its sides. With the secretion these ribbons the growth of the lac cell begins. But while the insect body continues to grow in length the dorsal wax shield does not. Consequently later on there is a disruption in the original arrangement of its plates, separation being in front as well as posteriorly. The anterior plates, 2 and 3, as shown here in figs. 1, and 2, reveal a separation, and more so the posterior ones, 7 and 8, being regions of the body underneath where it has expanded lengthwise. Now the first stage larvae, when full grown, show that the one belonging to the wingless male is larger than that of the female, while that of the winged male longest of the three. The separation between the dorsal wax-plates 2 and 3, and 7 and 8, is therefore best observed in the cell of the winged male larva. Now the dorsal shield of the first stage larva, being of wax, remains adhering to the roof of the cell. As the cell grows in height, from below upwards, the original position of the wax-shield remains undisturbed and persists as a relic upto the last when the cell belongs to the full grown adult female. Fig. 1 shows such a shield with its former disrupted arrangement of plates. It appears like a long fish-like object comprising of 11 partitions. Fig. 2 offers a key to fig. 1, and numbers the important dorsal plates. For producing fig. 1 the upper half, or the "dome", of a full grown cell of *Kerria sindica,* growing at Karachi, on *Zizyphus jujuba,* was taken. The insect, *K. sindica* is very allied in biological response to *K. communis,* on which a communica-

tion has appeared (in: S. Mahdihassan, 1963, *Eos, Madrid,* t. XXXIX, págs. 423-435). The species *sindica* was first described in 1923: "Classification of lac insects from a physiological stand-point", *J. Sci. Assoc. Maharajah's College, Viziamagram,* vol. 1: págs. 47-99. Its generic name *Kerria* was first coined by Tozzetti, in 1884, and its claim to priority has recently received by R. K. Varshney and has been accepted by the International Commission on Zoological Nomenclature, London; Varshney's paper is entitled: "The Indian lac insect, a change in nomenclature", *Indian J. of Entomology,* 1966, 28: págs. 116-118. All the specimens studied here belonged to the same source, *K. sindica.* The "dome", was cleaned of insect debris and photographed under a polarizing microscope. The first plate of the dorsal shield is triangular, having three corners; it bears no. 1, in fig. 2. The second plate is the largest, with four "horns" or corners; it bears no. 2, in fig. 2. Thus body segment no. 2, underneath wax plate no. 2, in its larval stage, was the largest of all. This segment carries the head below, the major spiracles on the sides, and the Brachial plates on the dorsal surface. The Brachial plate is a structure special to the lac insect. It represents fused ducts of glands secreting filaments of soft wax. Connecting the Brachial plate above with the major spiracle on the side lower down, a tube of hard wax forms an air passage for insect respiration. Now the Brachial plate above remains free of lac secretion. Its position on the cell therefore represents a hole into which the Brachial plate is fixed. For our purpose here, Brachial plate hole on the cell's dorsal surface are taken as identical, since emphasis is placed on the cell and not on the insect body. Thus in fig. 2 the object, marked B., actually represents the Brachial hole of the adult cell.

When the cell grows in height this is brought about by wax-fibres or wax-pencils being secreted collectively as ribbons from the sides. There ribbons are seen radiating side ways like ribs with the dorsal shield appearing like a back-bone. Figs. 1 and 2, show these wax-ribbons, but not being important here have not been numbered.

It is time to explain the role of exudation from the sides collectively called here wax-ribbons. All around the body there are patches of glandular pores. Each pore secretes a fibre or pencil of hard wax and the entire product of the patch appears like a flat ribbon. Now there is a correspondence between the plates of the dorsal shield and the wax ribbons produced from the sides. Thus the first body segment, no. 1 in fig. 2, has a triangular plate. The segment underneath

produces three ribbons around it. In fig. 3 there should have been three such ribbons in front but only one is seen, marked no. 1. The second plate, marked 2, in fig. 2, is the largest and has four horns or projections.

The segment underneath is the largest of all in the body; it has therefore four ribbons, a pair on each side; the pair on the right being marked 2, in fig. 3. Segments 3 to 10 all have on their back a wax plate with one projection on either side as seen in fig. 2; and correspondingly, in fig. 3, there is one ribbon on each side; in fig. 3 every ribbon to the right has been numbered according to the body segments producing them. In our previous communications we have credited segments 3 or 4 to have secreted a pair of ribbons. This has been a mistake and we beg to correct it here. Body segment, no. 2, as the largest, alone secretes two ribbons on either side.

The ribbons from a skeleton work around which the lac cell is built. Those waxes direct the secretion of lac and thus shape the cell. When they radiate sideways the cell expands in breadth; when they press downwards the cell is raised vertically; and when they project posteriorly the cell elongates itself in that direction. In fig. 3, being seen from above, we can not recognize if the body of the insect is raised. But ribbons 2 to 5 clearly show the cell must have broadened in the middle. Then ribbons 6 to 10 gradually face towards the posterior end showing the cell has lengthened itself in that direction.

We are still left to consider wax product numbered 11. The Anal Aperture of the cell is a hole into which the Anal Tubercle moves freely up and down. If lac exudation were not controled, this hole would be blocked. To prevent this, body segment no. 11, produces two short concave plates, together forming a truncated cone into which lies the Anal Tubercle. Fig. 3 therefore shows wax products no. 11 as different in shape to the other ribbons. The concave plates serve as dyke against the overflow of lac secretion. Lac is produced from glands all over the body and has to be controled by the hard wax secretion we are just considering.

Fig. 3 belongs to the larva of a winged male which has a specially long body thus helping its identification. Between the ribbons of the second segment, marked 2, on the right, is a clear space. This is occupied by the Brachial passage, marked with an arrow on the opposite side. Ribbons 3 to 5 are radiating outwards to broaden the cell. From 6 upto 10 they are trying to lengthen it posteriorly and in doing

so, they have turned themselves on their sides; ribbons 9 and 10 particularly appear long rather than flat. Ribbons 6 to 8, on the left, show clearly how they are flat on the top but are turned on their sides where they terminate. It must be pointed out that fig. 3 represents a cell formed by the first stage larva but its present occupant is in its early second stage.

In fig. 3 the larval body appears long. This is more so by the time the second stage winged male larva is fully formed as in fig. 4; in fig. 3 it is in its earliest stage, in fig. 4 fully grown, both representing second stage larvae. The male leaves its cell from a hole in its posterior dorsal surface. The cell forms there a cincular lid, free from wax, which easily breaks off and offers an exit to the adult male. This lid is called the Opercular lid. The corresponding part of the body appears like a shallow crater, in fig. 4. The posterior extremely ends with a brush of Anal Ring Hairs. The anal brush in the first stage larva comprises of 6 hairs but in the second of 10, so that in fig. 4 they were 10, a character which easily enables ascertaining if the first ecdysis had occured or not. In an earlier article of this review (S. Mahdihassan, 1963, *Eos, Madrid,* t. XXXIX, plate IV, fig. 2), the fully formed cell of the second stage wingless male larva has been shown with the Opercular lid marked "O". The cell ends posteriorly in a notch into which had fitted the Anal Brush. Thus fig. 4 here is the occupant of a cell similar to that seen in fig. 2 of the above mentioned article. Contrasting an early second stage male larva, fig. 3, there is fig. 5, which belongs to a corresponding female. Here again the cell was built during the first stage but the occupant is now in its early second stage. The front segment, as expected, has secreted three wax ribbons, each being marked 1, in fig. 5. These ribbons correspond to the three cornered dorsal shield plate, no. 1, in fig. 2. The largest body segment, no. 2, has produced four wax ribbons, the pair on the right being jointly indicated with number 2, in fig. 5 whereas the corresponding ones on the left are the most conspicuous of all ribbons. Between the pair of wax ribbons of the second segment lies the Brachial passage marked with an arrow in fig. 5. Body segment no. 3 secretes only one ribbon on either side; in fig. 5 the one on the right is marked 3. In our previous communications we have attributed segment 3 as producing a pair of ribbons. This is a mistake and only body segment no. 2, as the largest, produces two ribbons on either side. Wax ribbons 4 to 5 are self evident, though not indicated. A glance at ribbons 6 and

7 shows how they are gradually pointing posteriorly. This is quite obvious when we observe ribbons 8 to 10, as already discussed.

The pair of wax plates no. 11 is not seen to its best advantage in fig. 5 whereas the same is clear enough in fig. 3. Comparing figs. 3 and 5 the long slim body of the male larva in fig. 3 needs no further description. In fig. 5 the body of the female larva is broader at the front while even the posterior end more developed and broader between wax-ribbons 8 on either side of it.

The two cells, figs. 5 and 6, contain second stage female larvae while that of fig. 6 is the older. In fig. 6 the wax ribbons are seen to their best advantage, all being obvious and selectively indicated. The body has secreted three ribbons in front, each being numbered 1. The second body segment, as the largest, has a pair of ribbons on either side, that of the right bears number 2. The Brachial passage lies between the ribbons of the second segment and is marked with an arrow on the opposite side. Wax ribbons no. 10 are seen, at their best, projecting posteriorly and seem to be raised above the base of the cell. It has been mentioned that the Anal Aperture is kept as an open hole by concave wax plates, no. 11. Apparently to supplement them, wax-ribbons no. 10 are also raised above to help prolonging the cell posteriorly and thereby preventing lac secretion accumulating and blocking the Anal Opening. The larva, in fig. 6, being older, its body has a broader anterior margin than that found with the larva of fig. 5. Likewise the posterior end of the body, in fig. 6, is clearer because it is more developed than in fig. 5. The special feature, in fig. 6 is the separation among the series of wax ribbons enabling each to be recognized.

When the body has expanded in an old cell built previously it becomes relatively misfit. The cell appears to possess shorter wax ribbons merely because they are now covered by an occupant with a broader body. Such is the case with fig. 7. Here the ribbons were actually the same as in fig. 6 but the larva has grown so that the former ribbons, being partly covered, appear shorter. The body outline of the larva in fig. 7 is typical of the female, being elliptical with broader anterior and posterior ends. It is the posterior region that develops a prominent Anal Tubercle of the adult female. Even in the second larval stage it is becoming conspicuous enough. The wax ribbons are all clearly seen and 6 to 10 individually numbered. Ribbons 8 and 9 are seen curved and pointing inwards due to the expanded female larval

body particularly in the posterior region. The pair of ribbons no. 10 is projecting again as was the case in fig. 6. The second body segment is the largest. Its ribbons, marked no. 2, are the most prominent of all in fig. 7. On their opposite side is marked an arrow which shows the wax that lines the Brachial passage. The wax lining is so clear in this case as to be mistaken for a wax-ribbon which however it is not.

On comparing the posterior end of the larval body in figs. 5 to 7 it will be obvious that it is gradually getting broader in that region. Fig. 8 represents a second stage female larva which is old enough to produce its own secretion products which are conspicuous enough to be impressive. In fig. 8 the entire body outline is clear; anteriorly it is flat and posteriorly the Anal Tubercle is a conspicous prolongation. This part of the body in fig. 8 may be compared with that of fig. 6 to realize the special development of Anal Tubercle. The wax ribbons seen in fig. 8 represent a mixture of those secreted by the first and the second stage larvae, but with those of the latter predominating. In the second stage the cell produces three pairs of ribbons from each side; those on the right have been marked as best as it is possible in fig. 8. Between the pairs of ribbons, marked 1 and 2, lies the Brachial passage, by now broad enough to be impressive, and has been indicated with an arrow. It will be noticed that the middle portion of the body has buldged out, clearly so on the right bordering on ribbons marked 2.

Fig. 9 shows a cell only a little more advanced than of fig. 8. Here the wax ribbons of the second stage are clearly seen without any admixture or relics left by the first stage. The insect body is seen tilted on the left which shows buldging in the middle on the right from where the pair of ribbons, no. 2, arises. The three pairs of ribbons on the right are all marked. Between the first and the second pair lies the Brachial passage marked with an arrow. The Anal Tubercle is not seen so well in fig. 9 as in fig. 8, but nevertheless clear enough.

When cells are of the same age the rate of growth does not necessarily present them at the same stage of development. Figs. 9 and 10 represent cells of the same age but in the latter there are more relics of the first stage cell. However fig. 10 seems to be closer to fig. 8 than to fig. 9. Fig. 10 represents a larval body with its middle region buldging quite clearly, where 2 is marked on the left. Then its Anal Tubercle has a broader end in fig. 10 than in fig. 9. The three pairs of ribbons mixed with previous relics are not clear but have been numbered, on the left.

It is the prominent buldging of the body in the middle region in fig. 10 that induced us to interpret it as the stage preceding that of the full grown second stage female larva to be seen in fig. 11. Here we find a flat anterior margin and a similar posterior one, with the Anal Tubercle raised up so that its outline does not appear impressive enough being seen directly from above. The body is clearly buldged out on either side in the middle, so that as an object it appears six-cornered. The ribbons are separate as pairs which are no longer so separate in the third stage, fig. 12. The ribbons in fig. 11 have been duly numbered. This picture, fig. 11, may be compared with a pen and ink outline of the second stage larva (see: S. Mahdihassan, *Zool. Anz., Leipzig,* tomo XCIV, págs. 230-244). The superior technique of employing polarized light would be at once apparent. The actual picture to be compared there is also fig. 11.

As soon as the second moult occurs the secretion of wax ribbons becomes most conspicuous. An early third stage cell is seen in fig. 12. Here again there are three pairs of wax ribbons on either side but so close as to appear as one each; the ribbons on the left have been numbered. By placing a cell under a polarizing microscope it would be most easy to identify if it belongs to the late second stage, as fig. 11 does, or an early third stage, as fig. 12, is. Fig. 12 also incorporates relics of earlier wax-ribbons but those of the third stage are so dominant that the presence of other relics does not compare with the main secretion products.

Summary.

The lac cell is constructed on a structure of hard wax fibres in the form of flat ribbons. Such wax secretion of the male and female first and second stage larval cells has been studied in situ under polarized light.

The technique of using polarized light is more convenient to that of treating lac cells with solvents to dissolve lac resin and leave insoluble waxes behind.

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EXPLANATION OF PLATES IV, V AND VI.

LÁM. IV:

Fig. 1.—*Kerria sindica,* full grown adult female cell showing waxes as relics of the first stage cell. The original dorsal wax shield appears as a fish-like object and on its sides long projecting wax-ribbons that issued from the sides of the larval body.

Fig. 2.—Key to fig. 1. The original dorsal shield comprises of 11 plates, here selectively numbered. The long projections radiating sideways are wax ribbons not indicated. B., is the Brachial Opening of the adult cell.

Fig. 3.—Early second stage larva of winged male in a cell formed by the first stage. Wax-ribbons from the sides are individually numbered. The largest body segment, or the second, produces a pair of ribbons on each side, those on the right marked 2. The pair of ribbons, no. 10, are by no means parallel in the male cell.

Fig. 4.—Full grown second stage larva of winged male. Its posterior surface has a crater like depression corresponding to the Opercular lid of its cell. At the posterior extremity the Anal Ring Hair Brush comprises of 10 hairs.

LÁM. V:

Fig. 5.—Early second stage female larva contemperaneous with that of the male, fig. 3, still occupying its first stage cell. The latter has in front three wax-ribbons each marked 1. Second body segment, as the largest, produces four ribbons, two on the right marked 2. Between this pair lies the Brachial passage shown by an arrow. Ribbons 8 to 10 constitute a posterior unit elongating the cell in that direction. The female larva now has a broader body outline both anteriorly and posteriorly.

Fig. 6.—Female second stage larva with a flatter frontal outline and a more developed posterior region. All wax ribbons are separate from one another and selectively numbered. The frontal region has three ribbons, and ribbons no. 10 are parallel, unlike those in the male cell, fig. 3.

Fig. 7.—Female larva more advanced than that of fig. 6. The body has expanded and the old cell appears short for it. The ribbons 6 to 10 are all numbered with the pair 10 as parallel. The Brachial wax passage is indicated by an arrow on the left opposite to the pair of wax ribbons marked 2.

Fig. 8.—Second stage female larva producing its own wax ribbons as three pairs on each side, those on the right being numbered. The waxes seen are of mixed origin, of the first and second stage cells. The flat body outline, in front and the posterior end, is typical of second stage. The arrow on the right indicates the Brachial passage. The prominent Anal Tubercle is self evident.

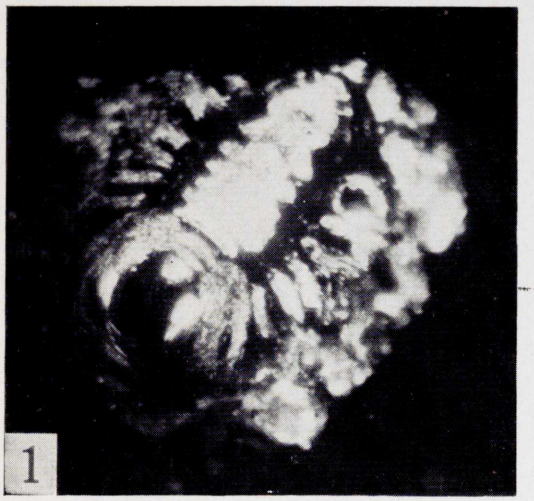
LÁM. VI:

Fig. 9.—Second stage female cell incorporates three pairs of wax ribbons on either side, the pairs on the right being marked.

Fig. 10.—The second stage larval body later on shows a buldging in the middle, thus dividing it into three regions. Wax ribbons, as three pairs on the left, are numbered. There also other waxes as relics.

Fig. 11.—Fully formed second stage female larva with flat anterior and posterior margins, and a buldging of the body on either side in the middle, thereby appearing as a six cornered object. All waxes seen belong to the second stage cell, comprising of three pairs of ribbons on either side, those on the left being numbered.

Fig. 12.—Early third stage female larva producing much broader wax ribbons, with three pairs on each side, those on the left being numbered.



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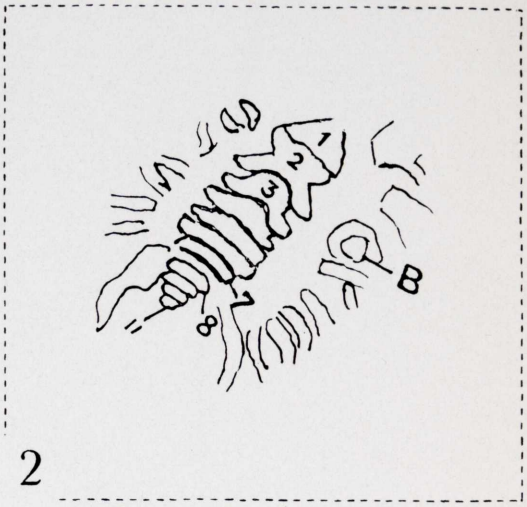

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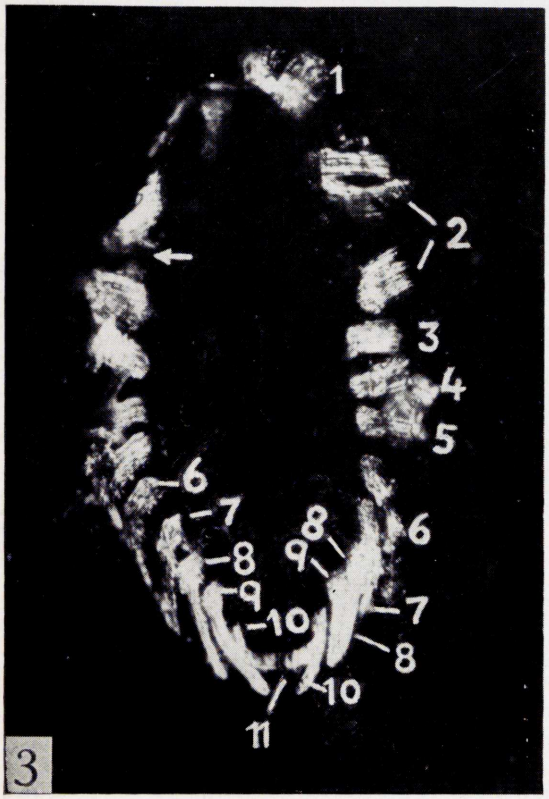

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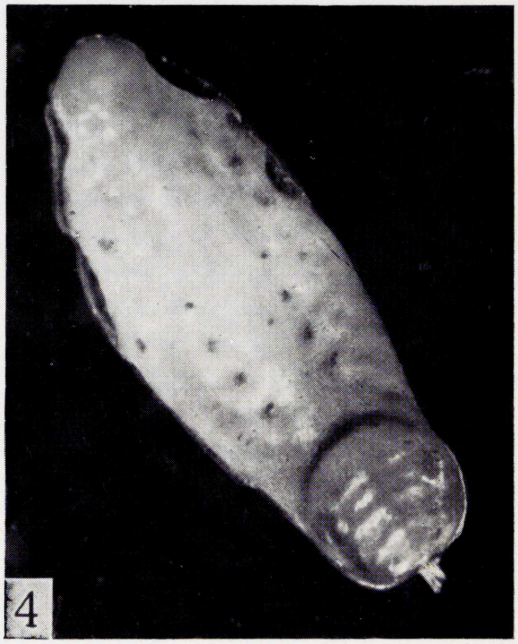

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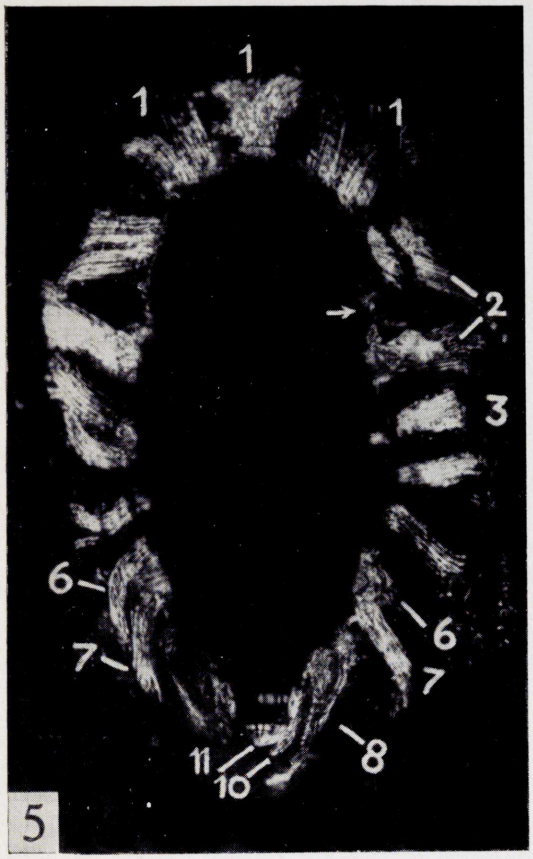
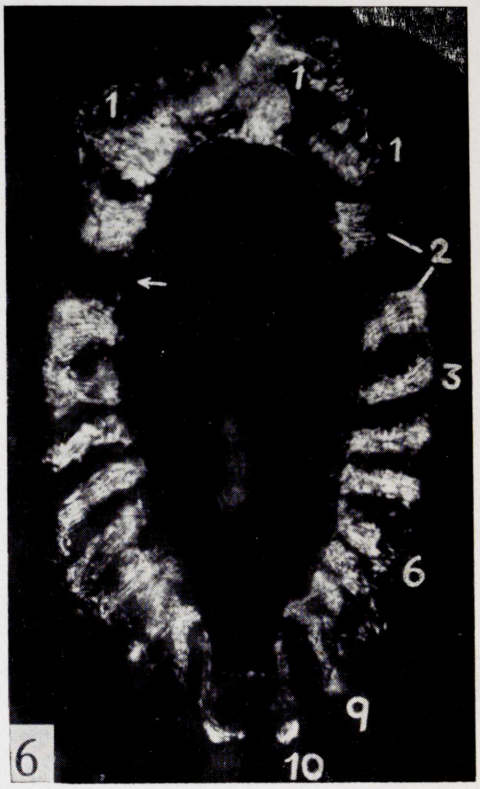
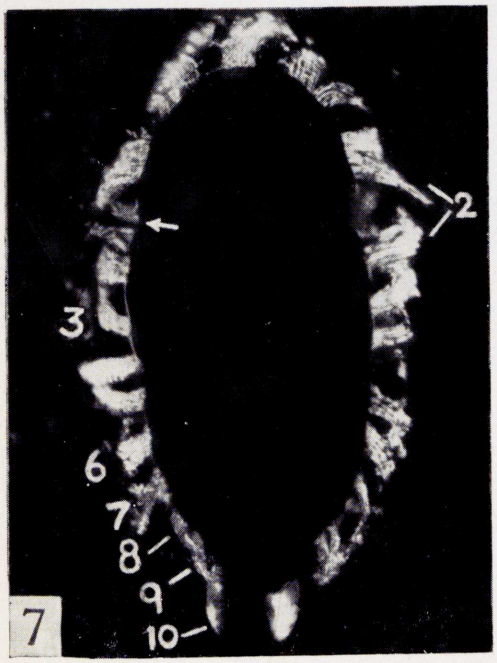
Noorun-Nisa Quadri and S. Mahdihassan: The second stage female lac cell under polarized light.







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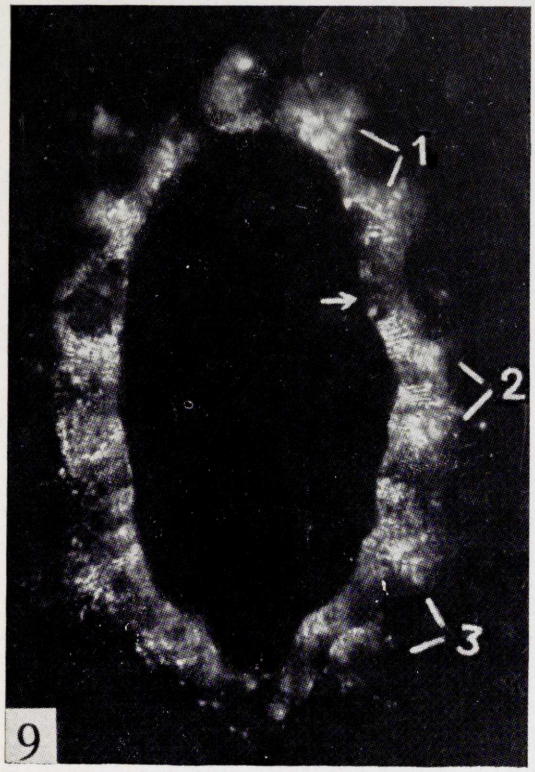

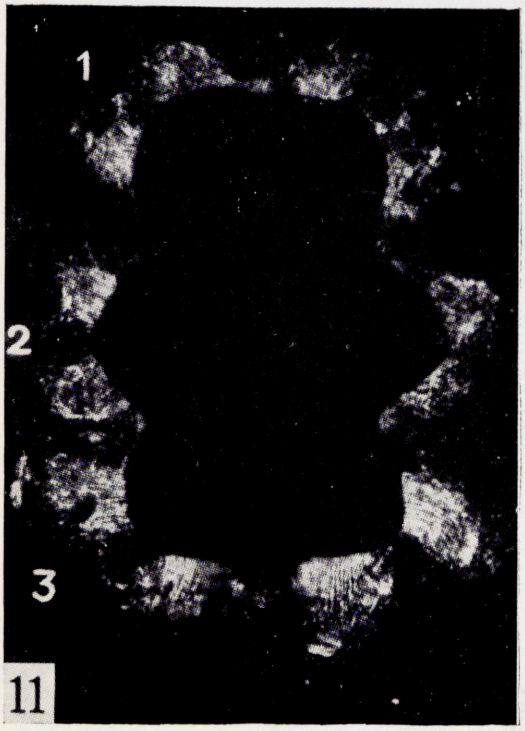

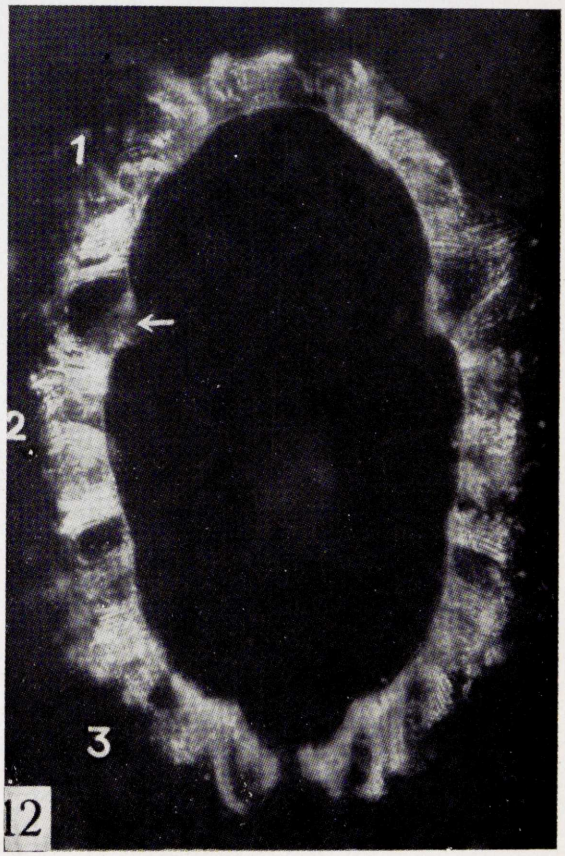

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